ETSI TS 105 174-2-2 V1.1.1 (2009-10)

Technical Specification

**Access, Terminals, Transmission and Multiplexing (ATTM);
Broadband Deployment - Energy Efficiency
and Key Performance Indicators;
Part 2: Network sites;
Sub-part 2: Data centres**

Reference
DTS/ATTM-02005-1-3

Keywords
access, cable, optical, site engineering

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://webapp.etsi.org/IPR/home.asp).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

The present document is part 2-2 of a multi-part deliverable. Full details of the entire series can be found in part 1 [13].

Introduction

The increasing interaction between the different elements of the Information Communication Technology (ICT) sector (hardware, middleware, software and services) supports the concept of convergence in which:

- multi-service packages can be delivered over a common infrastructure;
- a variety of infrastructures is able to deliver these packages;
- a single multi-service-package may be delivered over different infrastructures.

As a result of this convergence, the development of new services, applications and content has resulted in an increased demand for bandwidth, reliability, quality and performance, with a consequent increase in the demand for power which has implications for cost and, in some cases, availability. It is therefore important to maximize the energy efficiency of all the network elements necessary to deliver the required services.

New technologies and infrastructure strategies are expected to enable operators to decrease the energy consumption, for a given level of service, of their existing and future infrastructures thus decreasing their costs. This requires a common understanding among market participants that only standards can produce.

The present document is part 2-2 of a multi-part deliverable which has been produced by ETSI Technical Committee Access, Terminals and Transmission, Multiplexing (ATTM) in close collaboration with CENELEC via the Co-ordination Group on Installations and Cabling (CGIC). It offers a contribution to the required standardization process by establishing an initial basis for work on ICT networks and transmission engineering, with active collaboration from a number of other ETSI and CENELEC Technical Bodies. When complete, the multi-part deliverable will contain information that has been jointly evolved to present developments in installations and transmission implementation, and describing their progress towards energy efficiency in Next Generation Networks (NGN).

In order to monitor the implementation and operation of energy efficient broadband deployment, the present document also discusses Key Performance Indicators (KPI) for energy efficiency and focus on the possible consequences of standardization of installations, cabling techniques and equipment. In particular, the study will investigate possibilities and suggest solutions for development of processes for optimization in installation techniques and energy consumption.

1 Scope

The present document details measures which may be taken to improve the energy efficiency within operators sites and data centres for broadband deployment. Clauses 2 and 3 contain references, definitions and abbreviations which relate to this part; similar information will be included in the corresponding clauses of the other parts, thus ensuring that each document can be used on a "stand-alone" basis.

Within the present document:

- clause 4 introduces data centre concepts including those specifically related to network operators;
- clause 5 develops the concept of Key Performance Indicators (KPI), introduced in TS 105 174-1 [13], to enable consistent monitoring of energy efficiency;
- clause 6 details the approaches that may be employed to improve energy efficiency within the information technology infrastructure;
- clause 7 details the approaches that may be employed to improve energy efficiency within the environmental control systems;
- clause 8 details the approaches that may be employed to improve energy efficiency via the physical infrastructure of the buildings;
- clause 9 details the approaches that may be employed to improve energy efficiency within the power distribution system;
- clause 10 provides a summary of energy efficiency approaches within existing data centres;
- clause 11 provides a summary of energy efficiency approaches within new data centres and introduces wider issues concerning their location;
- clause 12 contains the conformance mechanisms of the present document;
- clause 13 contains the recommendations of the present document;
- clause 14 introduces future opportunities for improvements of energy efficiency;
- annex A provides indications of the first order effect of applying the approaches outlined in clauses 6, 7 and 9.

This will enable the proper implementation of services, applications and content on an energy efficient infrastructure, though it is not the goal of this multi-part deliverable to provide detailed standardized solutions for network architecture.

The present document focuses on energy efficiency. The CO_2 footprint is not taken in account in the present document.

Two separate aspects of energy efficiency are considered as shown in figure 1:

- actions to improve energy efficiency in existing data centres in the short or medium term;
- actions to improve energy efficiency in new data centres, in medium or long term.

The domains under study are:

- in the Information Technology (IT) infrastructure: all aspects of the technical infrastructure in the data centre, including servers, storage arrays, backup libraries and network equipment including routers, switches, etc.;
- in the IT operational strategy: all consolidation initiatives, such as virtualization, physical or logical consolidations, usage of specific software and processes;
- in the technical environment: all aspects concerning energy usage, cooling and, more generally, all disciplines involved in the technical environment of the data centre.

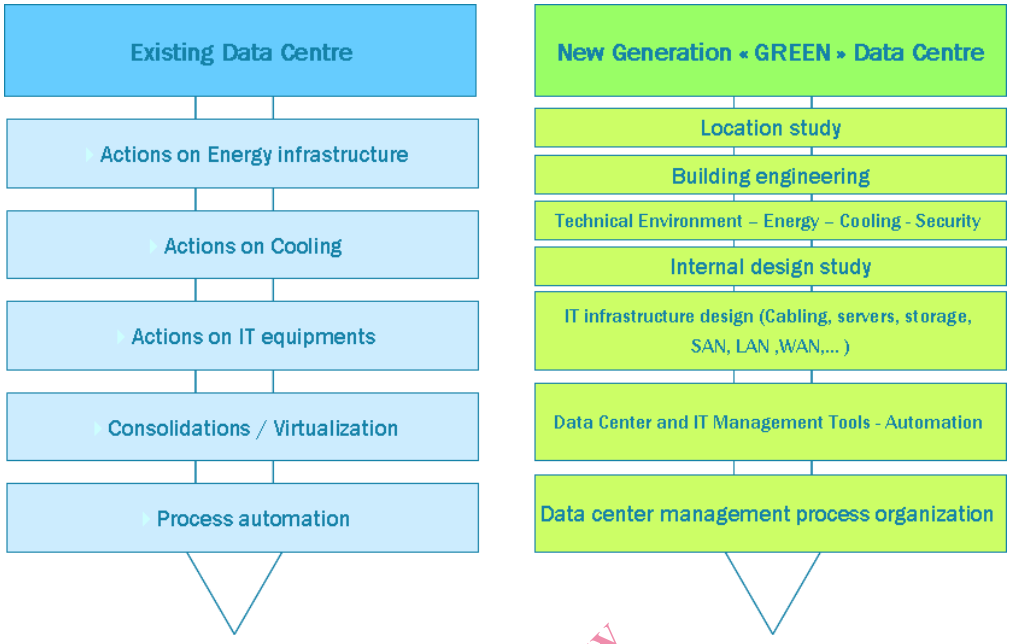

Figure 1: Aspects of data centres under consideration

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ANSI/TIA-942: "Telecommunications Infrastructure Standard for Data Centres".

[2] Uptime Institute: "Tier Classifications Define Site Infrastructure Performance".

[3] Johannesburg: "Datacenter Dynamics Research Key Findings" August 2008.

[4] European Commission: "DG-JRC Code of Conduct on Data Centres Energy Efficiency".

[5] "Best Practices for the EU Code of Conduct on Data Centres".

[6] CENELEC EN 50173-2: "Information technology - Generic cabling systems - Part 2: Office premises".

[7] CENELEC EN 50173-5: "Information technology - Generic cabling systems - Part 5: Data centres".

[8] CENELEC EN 50174-1: "Information technology - Cabling installation - Part 1: Installation specification and quality assurance".

[9] CENELEC EN 50174-2: "Information technology - Cabling installation - Part 2: Installation planning and practices inside buildings".

[10] High performance buildings: "UPS report (Ecos Consulting-Epri Solutions)".

[11] ETSI EN 300 019-1-3: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weatherprotected locations".

[12] ETSI EN 300 132-3: "Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V".

[13] ETSI TS 105 174-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment - Energy Efficiency and Key Performance Indicators; Part 1: Overview, common and generic aspects".

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ETSI TR 102 489: "Environmental Engineering (EE); European telecommunications standard for equipment practice; Thermal Management Guidance for equipment and its deployment".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

application: single program or a set of several programs executing a function or a service

availability: time or period during the application or the service has to be operational

NOTE: Availability is one of the criticality criteria.

blade server: server chassis housing multiple thin, modular electronic circuit boards, known as server blades

NOTE: Each blade is a server in its own right, often dedicated to a single application. The blades are literally servers on a card, containing processors, memory, integrated network controllers, an optional fibre channel host bus adaptor (HBA) and other input/output (IO) ports.

computer room: closed, secured and environmentally controlled room in which IT equipment is operating

criticality: level given to an application or service, linked to the impact for the enterprise in case of crash

NOTE: More the impact is strong, more the application or service is critical.

data centre: centralized repository for the storage, management, and dissemination of data and information organized around a particular body of knowledge or pertaining to a particular business

Data Centre Infrastructure Efficiency (DCIE): reciprocal of the PUE, that is "IT equipment power" divided by "total facility power", expressed as a percentage

NOTE: DCIE improves as it approaches 100 %.

Disaster Recovery Plan (DRP): all process (technical, organization, people) to launch in case of continuity disruption

disk array: cabinet containing physical disks

energy efficiency: search in existing DC, or for new future DC, of all tracks and actions allowing minimizing energy needs and costs

NOTE: Key drivers are Economic to decrease the energy bill by increasing the efficiency of all equipment and minimize power loss.

green data centre: in addition to energy efficiency, the "Green" approach will focus on carbon footprint

NOTE 1: Energy Efficiency is one way, to decrease CO_2 emissions, but it is not the only one.

NOTE 2: More "sustainable development" objective than economic, the key indicator is carbon footprint. Today, this concept is not still clearly defined, especially if we now that data centres are not directly producers of CO_2, but indirectly, due to their energy needs. If the source of power is becoming from renewable energies (hydraulic, solar, etc.) or nuclear (not so green for earth, but not producing CO_2) the carbon footprint of the datacenter is low. But if energy is becoming from coal, or fuel the CO_2 emissions are high.

information technology equipment: equipment such as computers, servers, mainframes, calculators and all storage devices as arrays, libraries, tape robots together with routers and switches within the local area networks

IT equipment power: total power needed for operate servers, racks, disk arrays, libraries, network telecommunications equipment (such as routers and switches), equipment used for monitoring the data centre (PC, laptops, terminals and workstations) and network telecommunications-specific equipment (such as DSLAM and BTS)

logical consolidation ratio: number of application instances per operating system image

logical server: one single instance of operating system

mainframe: high-performance computer used for large-scale computing purposes that require greater availability and security than a smaller-scale machine can offer

network telecommunications equipment: equipment providing direct connection to core and/or access networks including switches, DSLAM, BTS

operator site: premises accommodating network telecommunications equipment providing direct connection to the core and access networks and which may also accommodate information technology equipment

physical server: box containing supplies for energy, mother board, central processing unit, memory, slots

Power Usage Effectiveness (PUE): metric used to determine the energy efficiency of a data centre that is determined by "Total facility power" divided by "IT equipment power", expressed as a ratio (PUE is expressed as a ratio, with overall efficiency improving as the quotient decreases toward 1)

Recovery Point Objective (RPO): maximum allowed data loss

Recovery Time Objective (RTO): maximum authorized time during application or service can be stopped

server: computer program that provides services to other computer programs (and their users) in the same or other computers

total computing load: total computing power in the data centre, that can be evaluated by taking vendors specifications of computational power of each model of server multiplied by the number of servers (transactions per minute is one measure of total computing power)

total facility power: total power used by all power delivery components (such as uninterruptible power supplies, switches, power distribution units, batteries and transformers), cooling system components (such as chillers, computer room air conditioning units, pumps, fans, engines) and the non-technical energy (such as building lighting)

TPC Benchmark C (TPC-C): On-Line Transaction Processing (OLTP) benchmark measured in transactions per minute (TPMc)

NOTE 1: TPC-C is more complex than previous OLTP benchmarks such as TPC-A because of its multiple transaction types, more complex database and overall execution structure. TPC-C involves a mix of five concurrent transactions of different types and complexity either executed on-line or queued for deferred execution. The database comprises nine types of tables with a wide range of record and population sizes.

NOTE 2: TPC-C simulates a complete computing environment where a population of users executes transactions against a database. The benchmark is centred around the principal activities (transactions) of an order-entry environment. These transactions include entering and delivering orders, recording payments, checking the status of orders, and monitoring the level of stock at the warehouses. While the benchmark portrays the activity of a wholesale supplier, TPC-C is not limited to the activity of any particular business segment, but, rather represents any industry that manages, sells, or distributes a product or service.

utility computing: service provisioning model in which a service provider makes computing resources and infrastructure management available to the customer needs

NOTE: Like other types of "on-demand computing" (such as grid computing), the utility model seeks to maximize the efficient use of resources and/or minimize associated costs. This approach is becoming increasingly common in enterprise computing and is sometimes used for the consumer market as well, for internet service, web-site access, file sharing, and other applications.

Virtual Machine (VM): emulation of a physical server on a shared infrastructure

NOTE: Virtual machine embeds Operating System, specific softwares and application.

virtual server: "piece" of physical server dedicated to run a "virtual machine"

virtualization: software that separates applications from the physical hardware on which they run, allowing a "piece" of physical server to support one application, instead of requiring a full server

virtualization ratio: number of Virtual Machines per server

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternative Curent
ADSL	Asymetric Digital Suscriber Line
AS	Application Server
ATTM	Access Transmission Terminal and Multiplexing
B2B	Business To Business
B2C	Business To Customer
BTS	Base Transceiver Station
CPU	Central Processing Unit
CRAC	Computer Room Air Conditioning
CRIP	Club des Responsables d'Infrastructure et de Production
DC	Data Centre
DCIE	Data Centre Infrastructure Efficiency
DRP	Disaster Recovery Plan
DSLAM	Digital Subscriber Line Access Multiplexer
HBA	Host Bus Adaptor
HQE	Haute Qualité Energétique
HVDC	High Voltage Direct Current
ICT	Information Communication Technology
IEC	International Electrotechnical Commission
IO	Input Output
IS	Information Systems
ISP	Internet Service Provider
IT	Information Technology
ITIL	IT Information Library

KPI	Key Performance Indicator
LEED	Leadership in Energy and Environmental Design
M2M	Machine To Machine
MVS	Proprietary Operating System for IBM Mainframes servers
NGDC	New Generation Data Centre
NGN	Next Generation Network
OLTP	On-Line Transaction Processing
OS	Operating System
PDU	Power Distribution Unit
POD	Performance Optimzed Datacenter
PUE	Power Usage Effectiveness
RISC	Reduced Instruction Set Computer
RPO	Recovery Point Objective
RTO	Recovery Time Objective
SAN	Storage Area Network
SLA	Service Level Agreement
TCO	Total Cost of Ownership
TPC-C	TPC Benchmark C
TPM	Transaction Per Minute
TPMc	transaction per minute - count
TV	TeleVision
UPS	Uninterruptible Power Supply
VM	Virtual Machine
VMS	Proprietary Operating System for DEC Mainframe Servers
VOD	Video On Demand
VOIP	Voice Over IP
WAS	Web Access Server

4 Overview of data centres

4.1 Types of data centres

There are a number of different types of data centre:

- **a network data centre** has the primary purpose of the delivery and management of broadband services to the operator's customers. To enable their functionality, all network data centres must be connected to at least one core network operator site. For reasons of network resilience, data centres will invariably be connected to more than one operator site and to several other data centres. Data Centres may serve core networks operated by several network operators, thus enabling traffic between customers of different network operators;

- **an enterprise data centre** has similar functions and connectivity functions and connectivity to that of a network data centre but has the primary purpose of the delivery and management of services to its employees and customers;

- **a co-location data centre** is one in which multiple customers locate their own network, server and storage equipment and have the ability to interconnect to a variety of telecommunications and other network service providers. The support infrastructure of the building (such as power distribution, security, environmental control and housekeeping services) is provided as a service by the data centre operator;

- **a co-hosting data centre** is one in which multiple customers are provided with access to network, server and storage equipment on which they operate their own services/applications and have the ability to interconnect to a variety of telecommunications and other network service providers. Both the information technology equipment and the support infrastructure of the building are provided as a service by the data centre operator.

This clause will identify and explain the elements of the network sub-systems employed in broadband deployment.

4.2 Tiering of data centres

4.2.1 Tiers and criticality

Several levels of data centres have been defined, based on the criticality of the applications or the business processed which determine the global Recovery Time Objective (RTO). The lower the RTO, the more the data centre has to be supported by the use of redundant equipment in both the technical environment and IT infrastructure domains.

A number of schemes defining levels of data centres have been developed that are considered in the following clauses.

4.2.2 ANSI/TIA-942

ANSI/TIA-942 [1] defines requirements for reliability and availability of data centres, including the associated redundant support infrastructures, based on four "tiers". Network data centres are assumed to at least meet the requirements of Tier 3.

4.2.3 Uptime Institute

The Uptime Institute [2] defines an alternative system of "Tiers" based upon business objectives and acceptable downtime as shown in table 1. The Tier determines the redundancy of energy and cooling equipment as indicated in table 1 and shown in figure 2 and has some significant consequences on energy costs.

Table 1: Uptime Institute Tiers

Tier	Impact of failure	Design criteria	Downtime (maximum)
1	Internal company impact Mostly cash-based Limited on-line presence Low dependence on IT Downtime perceived as tolerable inconvenience	Single path for power and cooling distribution No redundant components	28,8 hours/year
2	Business critical applications Multiple servers Telephone system vital to business Dependent on e-mail	Single path for power and cooling distribution Redundant components	22,0 hours/year
3	World-wide presence Majority of revenue from on-line business VoIP telephone system High dependence on IT High cost of downtime	Multiple power and cooling distribution paths but only one path active Redundant components; concurrently maintainable	1,6 hours/year
4	Strategic or mission critical business Majority of revenue from electronic transactions Business model entirely dependent on IT	Multiple active power and cooling distribution paths; redundant components; fault	0,4 hours/year